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and the heat exchanger are more successful in detecting a dangerous temperature than the single thermal fuse 3'. However, even plural thermal fuses in scattered positions do not always succeed in detecting a dangerous temperature since "blind spots" may exist. Also, it takes much time and trouble to provide plural thermal fuses in scattered positions. It is also expensive to provide plural thermal fuses.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a safety device for a combustion apparatus which is capable of detecting an excessively high temperature of the combustion apparatus whichever portion in an intended area of the apparatus is subjected to such a temperature and stopping the combustion in the combustion apparatus at the same time that the safety device detects the excessively high temperature.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows prior art;

Fig. 2 is a vertical cross section of a hot-water supply apparatus with a first embodiment of the invention;

Fig. 3 is a horizontal cross section taken on line X-X of Fig. 2;

Fig. 4 shows a temperature sensing element;

Fig. 5 is a view similar to Fig. 3 which shows a second embodiment of the invention;

Fig. 6 is a view similar to Fig. 3 which shows a third embodiment of the invention;

Fig. 7 is a view similar to Fig. 3 which shows a fourth embodiment of the invention; and

Fig. 8 shows a fifth embodiment of the invention.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Different embodiments of the invention will now be described with reference to Figs. 2 to 8.

Figs. 2 and 3 show a first embodiment of the invention. Fig. 2 is a vertical cross section of a hot-water supply apparatus which uses a fan to supply air and employs gas to heat water, while Fig. 3 is a horizontal cross section taken on line X-X of Fig. 2. In Fig. 2 the hot-water supply apparatus is fixed to a wall.

The hot-water supply apparatus of Figs. 1 and 2 includes a combustion chamber 1. A water-supply pipe 4 is wound round the combustion chamber 1. Although it is difficult to have an idea of what the overall shape of the water-supply pipe 4 is from Figs. 2 and 3, the water-supply pipe 4 is wound round the combustion chamber in a helical shape. A heat exchanger 2 is located on the combustion chamber 1. The heat exchanger 2 has a heat-absorbing conduit 5. The upper end of the water-supply pipe 4 is connected to an inlet of the heat-absorbing conduit 5. An outlet of the heat-absorbing conduit 5 is connected to a hot-water supply pipe 4a. A gas burner 6 is located in a lower portion of the combustion chamber 1. An air supply chamber 7 is located beneath the gas burner 6. The air supply chamber 7 is separated from the gas burner 6 by a horizontal partition plate 10. However, the partition plate 10 is provided with openings and, thus, the air supply chamber 7 communicates with the gas burner 6 through these openings. A fan 8 is located in the air-supply chamber 7. When the fan 8 is operated, a current of air is created. The air passes from the air-supply chamber 7 through the openings of the partition plate 10 into the gas burner 6. The air is used for combustion by the gas burner 6. The gas burner 6 heats the heat exchanger 2. Water supplied into the heat-absorbing conduit 5 from the water-supply pipe 4 is thus heated. The hot water comes out from the hot-water supply pipe 4a into a kitchen sink or a bath.

A temperature sensing element 3 is located at the back of the combustion chamber 1 and the heat exchanger 2. The rear



portion of the water-supply pipe 4 is located between the combustion chamber 1 and the temperature sensing element 3. The temperature sensing element 3 is made of a material which is electrically conductive and melts at a relatively low temperature, such as lead, tin, or an alloy of lead and tin. Also, the temperature sensing element has a continuous, linear shape. For example, the temperature sensing element 3 may be formed such that it has a shape of Fig. 4 when viewed from the right side of Fig. 2. The temperature sensing element 3 is connected, at both its ends, to a combustion control circuit (not shown) by means of leads 11.

In use, if the rear of the combustion chamber 1 or of the heat exchanger 2 reaches such a high temperature as to be cracked or perforated, the portion of the temperature sensing element 3 nearest to the hottest portion of the rear of the combustion chamber 1 or of the heat exchanger 2, or nearest to the portion thereof which has been cracked or perforated, melts. When the temperature sensing element 3 thus melts, or breaks, the combustion control circuit is de-energized. Thus, a fuel control valve is closed to stop the fuel from being supplied to the gas burner.

With regard to melting point, the temperature sensing element 3 can be formed such that it melts at a temperature of from 120 to 200°C.

The shape of Fig. 4 is one possible example of the shape of temperature sensing element 3. Temperature sensing element can be formed in any other shape whereby it melts when any portion of the rear of the combustion chamber 1 or of the heat exchanger 2 has reached an excessively high temperature, or such a high temperature as to be cracked or perforated.

In Figs. 2 and 3 reference numeral 12 designates an air exhaust pipe; reference numeral 13, a shell; reference numeral 14, a heat insulating material; and reference numeral 15, air intake ports.

Fig. 5 illustrates a second embodiment of the invention. That is, if temperature sensing element 3 is located in front of the combustion chamber 1 and the heat exchanger 2, the tempera-



ture sensing element 3 can detect an excessively high temperature of the front of the combustion chamber 1 or of the heat exchanger 2 by melting.

Fig. 6 illustrates a third embodiment of the invention. That is, if a temperature sensing element 3 surrounding the rears and opposed sides of the combustion chamber 1 and of the heat exchanger 2 is used, such a temperature sensing element 3 can detect an excessively high temperature of the rear or opposed sides of the combustion chamber 1 or of the heat exchanger 2 by melting.

Fig. 7 illustrates a fourth embodiment of the invention. That is, if a temperature sensing element 3 surrounding all sides of the combustion chamber 1 and of the heat exchanger 2 is used, such a temperature sensing element 3 can detect an excessively high temperature of any side of the combustion chamber 1 or of the heat exchanger 2 by melting.

Fig. 8 illustrates a fifth embodiment of the invention. That is, if desired, a temperature sensing element 3 may be printed on a sheet 18. Then, the sheet 18 can be used instead of the temperature sensing element of Fig. 2 or 5. Also, it will be appreciated that a temperature sensing element 3 may be printed on a base material having a shape similar to the shape of the temperature sensing element 3 of Fig. 6 or 7.

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What is claimed is:

1. A safety device for a combustion apparatus, comprising a continuous, linear temperature-sensing element formed of a material which is electrically conductive and melts, or breaks, at a relatively low temperature,

said temperature-sensing element being located along at least one side of a combustion chamber of a combustion apparatus and one side of a heat exchanger thereof, and

said temperature-sensing element being electrically connected to a combustion control circuit such that, if and when said at least one side of said combustion chamber or of said heat exchanger has reached an excessively high temperature, said temperature-sensing element melts, or breaks to cause said combustion control circuit to stop a combustion in said combustion chamber.

2. A safety device in accordance with claim 1 wherein said temperature-sensing element is located along rears of said combustion chamber and of said heat exchanger.

3. A safety device in accordance with claim 1 wherein said temperature-sensing element is located along fronts of said combustion chamber and of said heat exchanger.

4. A safety device in accordance with claim 1 wherein said temperature-sensing element surrounds not only rears of said combustion chamber and of said heat exchanger, but also opposed sides of said combustion chamber and of said heat exchanger.

5. A safety device in accordance with claim 1 wherein said temperature-sensing element surrounds all sides of said combustion chamber and of said heat exchanger.

6. A safety device in accordance with claim 1 wherein said temperature-sensing element stretches in a zigzag line.



7. A safety device in accordance with claim 1 wherein said temperature-sensing element is printed on a sheet.



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